PATENT SPECIFICATION

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216,136

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COMPLETE SPECIFICATION.

Improvements in and relating to Elastic Fluid Turbines.

We, THE BRITISH THOMSON-HOUSTON COMPANY LIMITED, a British company having its registered office at Crown House, Aldwych, London, W.C. 2, (Assignees of ERNEST LEONELL RICHARDSON, formerly of Narberth, in the County of Montgomery, State of Pennsylvania, United States of America, now of 8, Harrison Street, Melrose Highlands, State of Massachusetts, United States of America, a citizen of the United States of America), do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to elastic fluid turbines of the type in which an elastic fluid is tapped from an intermediate stage for industrial purposes, such machines being ordinarily termed extraction turbines, and has for its object to provide means to control the amount of elastic fluid admitted to the turbine in accordance with the amount extracted at the intermediate stage.

The type of turbine employed is that provided with a nozzle diaphragm between the extraction stage and the next lower stage, valves for controlling the amount of elastic fluid passing to the nozzles operated by fluid pressure motors in response to the pressure in the extraction stage, and a main control valve differentially operated by both the speed governor and the extraction stage pressure responsive means. According to the invention, the extraction stage pressure responsive means controlling the fluid actuated motor for the valves between the extraction stage and next lower stage also controls an auxiliary supply of actuating fluid for the motor which operates the main admission valve of the turbine. The invention further consists of the novel combination of devices as hereinafter described.

In the accompanying drawing, Fig. 1 is a diagrammatic view partly in section of an elastic fluid turbine embodying our invention; Fig. 2 is a detail sectional view of certain parts; Fig. 3 is a transverse sectional view partly broken away taken through the extraction stage of the turbine and Fig. 4 is a detail longitudinal sectional view of a part of the turbine taken through one of the overflow or stage valves.

In the drawing, 10 indicates an elastic fluid turbine provided with an admission conduit 11 and a discharge conduit 12. Conduit 12 may be connected to a condenser in the well-known manner. In conduit 11 is a control valve 12^a of any suitable type which is opened and closed by a fluid-actuated motor 13 having its piston 14 connected to the stem 15 of valve 12^a. The pilot valve of the fluid-actuated motor is indicated at 16 and its stem 17 is connected by a floating lever 18 and a link 19 to the governor lever 20 of speed governor 21 driven from the shaft of the turbine in the usual way. Floating lever 18 is connected at an intermediate point to valve stem 15 thereby providing a usual form of follow-up device. The operation of a speed governor controlling a turbine admission valve through the intermediary of a fluid actuated motor is well known and its operation well understood. The arrangement shown is to be taken as typical of any suitable arrangement for performing this function. Leading from an intermediate stage of the turbine is an extraction conduit 22 through which elastic fluid of lower pressure may be drawn for industrial purposes.

In Fig. 4 the extraction stage is indicated by the reference letter A and the stage just beyond the extraction stage is

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indicated by the letter B. For example, A may be the first stage of the machine and B the second stage. Between turbine stages A and B is a diaphragm 23 provided with nozzles 24 through which elastic fluid is supplied to the bucket wheel 25 of turbine stage B. There are a number of groups of nozzles 24 and the admission of elastic fluid to each group is controlled by a balanced valve 26 arranged in a steam chest 27 as shown particularly in Fig. 3, there being a steam chest for each group of nozzles 24 for supplying elastic fluid to them. It will thus be seen that the flow of elastic fluid from turbine stage A to turbine stage B is controlled by the several valves 26. The stems 28 of valves 26 project beyond the turbine casing and are provided at their outer ends with heads 29 provided with slots 30 in which are pivoted rollers 31. Arranged between the outer ends of head 29 and guide frames 32 are springs 33 which serve to bias valves 26 toward closed positions. Surrounding the turbine shell is a ring 34 carried on rollers 35 and passing through slots 30 in heads 20. On ring 34 are cams 36 adapted to engage rollers 31 for opening valves 20. As best shown in Fig. 3, the cams are arranged so as to open the valves successively, the cam surfaces being spaced different distances away from the rollers. On ring 34 is a gear segment 37 which is engaged by a rack 38 carried on the lower end of the stem 39 of a fluid-actuated motor 40. The pilot valve of the fluid-actuated motor is indicated at 41 and comprises a casing 42 in which moves a valve stem 43 provided with the usual valve members 44 controlling the admission and discharge of actuating fluid to the main cylinder of the motor. The arrangement illustrated is a usual form of fluid actuated motor, the operation of which is well-understood.

Pilot valve stem 43 is connected to one end of a lever 45 pivoted on a fixed arm 46. The other end of lever 45 is connected by a rod 47 to the movable element of a pressure-responsive device here shown in the form of a flexible diaphragm 48 contained in a casing 49. The casing 49 above diaphragm 48 is open to the atmosphere. The casing below diaphragm 48 is connected by a pipe 50 to the extraction stage of the turbine. This means, therefore, that diaphragm 48 is subjected to the pressure existing at any time in the stage of the turbine from which elastic fluid is being extracted for industrial purposes. On the outer end of rod 47 is a spring plug 51 with which is connected one end of a spring 52. The other end of spring 52 is connected to a spring plug 53 which has threaded engagement with screw threads 54 on a sleeve 55. Connected to the lower end of sleeve 55 is worm wheel 56 with which engages a worm 57 mounted on the shaft of a reversing motor 58. With this arrangement it will be seen that when motor 58 is operated in one direction spring plug 53 will be moved upward to decrease the initial tension of spring 52, while when operated in the other direction it will be moved downward to increase the initial tension on spring 52. In this connection it will be noted that spring 52 is an extension spring in this instance. Motor 58 may be controlled manually or in any other suitable manner. According to one application of our invention, however, we preferably control it by means of mechanism responsive to the temperature in the apparatus to which extraction elastic fluid is supplied or to the temperature at any other desired point. To this end motor 58 is connected by lead wires 59 to a source of potential 60, the connection including a suitable reversing switch 61 which switch is adapted to be temperature controlled. In the present instance, we have illustrated diagrammatically an arrangement wherein the movable element of the switch is connected to an expansible diaphragm 62 which in turn is connected by a tube 63 to a casing 63^a which is subjected to the temperature at the point at which the temperature is to be maintained constant. In the present instance we have shown casing 63^a located in the extraction conduit 22 at the point where it connects with a device to be heated. Tube 63 and casing 63^a are filled with a suitable liquid which as it expands and contracts due to temperature changes operates diaphragm 62 to reverse the connections of the reversing switch 61. The tube 63 is made as short as possible for any particular installation and is suitably lagged to protect it from changes in room temperature, so that in substance the switch is operated by the expansion and contraction of the liquid in casing 63^a. Casing 63^a is made sufficiently large to give the desired operating range. It will be understood that the arrangement shown in the drawing is of a diagrammatic nature and that any suitable construction may be used for the purpose.

The operation of the arrangement so far described is as follows:—

Assume that the turbine is running and a certain amount of elastic fluid is being extracted through conduit 22 for indus-

trial purposes, the remainder passing through valves 26 to the lower pressure stages of the turbine. Some of the valves 26 may be entirely open, another partly open, and others entirely closed. If now the pressure in the extraction stage A increases due, for example, to the further opening of valve 12^a, (which may be caused by an increase in load on the turbine) or to a decrease in the demand for extraction steam, the pressure in the extraction stage will increase, thereby lifting diaphragm 48 against the action of spring 52 and lowering pilot valve 41 so as to admit fluid pressure to the cylinder of fluid-actuated motor 40 beneath the piston thereby moving the piston upward and turning ring 34 toward the left as seen in Fig. 3. This opens further the stage valves 26 to permit more elastic fluid to pass to the lower stages of the turbine thereby decreasing the pressure in the extraction stage. On the other hand if the pressure in the extraction stage decreases below the desired value then a similar operation will take place except in the opposite direction, valves 26 being closed to decrease the amount of elastic fluid which can flow from the extraction stage to the lower stage of the turbine and thereby increasing the pressure in the extraction stage. By this means the pressure in the extraction stage can be maintained substantially constant.

The pressure held by the fluid-actuated member 48 depends on the adjustment of spring 52 since it must operate against this spring in moving the pilot valve stem 43. As already stated, this spring may be arranged to be manually controlled if desired. With the temperature controlled arrangement shown in the drawing, if the temperature increases beyond a predetermined amount, reversing switch 61 will be moved to close circuit 59 to operate motor 58 in a direction to decrease the tension of spring 52 which means of course, that the extraction pressure is decreased. A decrease in the extraction pressure means, of course, that less elastic fluid will flow to the heating device whereby less heat will be supplied to it. This is due to the fact that at any instant the resistance opposing the flow has a fixed value so that the amount of flow is a function of the pressure. On the other hand if the temperature falls too low, operation in the opposite direction will take place increasing the tension of spring 52 and hence the extraction pressure and the flow of fluid to the heating device. Of course with changes in pressure there is a change in the temperature of the elastic fluid extracted but the amount is comparatively small for the pressures dealt with, the major effect in the temperature control being that due to increase and decrease in the amount of fluid supplied to the heating device due to the pressure changes.

When a change in stage pressure occurs in the extraction stage causing the valves 26 to open or close to admit more or less elastic fluid to the lower pressure stages of the turbine, the power ratio of the high pressure and lower pressure stages is disturbed which requires that valve mechanism 12 be moved to admit more or less steam. In other words, assuming that the load on the turbine remains the same, if more elastic fluid is extracted the high pressure valve 12 must be opened somewhat in order to supply this additional elastic fluid, while if less elastic fluid is extracted, the high pressure valve mechanism 12 must be closed somewhat to decrease the amount of high pressure elastic fluid admitted to correspond to the less amount extracted. In order to control more promptly the operation of the high pressure valve mechanism 12, when a change in the position of valves 26 takes place, we provide fluid-actuated motor 13 with an additional pilot valve 64, which is moved by pressure-responsive device 48. This additional pilot valve may be formed, with advantage, as a part of the pilot valve 41 and have its valve members 65 connected to the same pilot valve stem 43. 66 and 67 are conduits connecting pilot valve 64 to the cylinder of fluid-actuated motor 13, the one connection being above piston 14 and the other below piston 14, in the usual manner. With this arrangement it will be seen that whenever pilot valve 41 is raised so as to admit motive fluid above the piston of motor 40 thereby moving the piston down and valves 26 toward closed position, pilot valve 64 will be simultaneously raised so as to admit motive fluid through pipe 66 to the underside of piston 14 to effect a corresponding opening movement of the high pressure valve mechanism so as to admit more elastic fluid to the turbine and thus maintain its speed. On the other hand, when pilot valve 41 is lowered to effect an opening movement of the valves 26 then pilot valve 64 will be simultaneously lowered to admit motive fluid through pipe 67 to the overside of piston 14 to effect a closing movement of the high pressure valve mechanism 12 thereby decreasing the amount of elastic fluid admitted to the turbine. By this

means valve mechanism 12^a is controlled independently of the speed governor to take care of variations in stage pressure due to the opening and closing movements of valves 26. This means that the speed of the turbine can be maintained more nearly constant than would otherwise be the case.

In this connection it will be noted that when piston 14 moves in response to a movement of pilot valve 64, it moves pilot valve 16 in a direction to effect a counteracting movement of piston 14 thus effecting an equalisation of pressure on opposite sides of piston 14 pending a restoring of pilot valves 64 and 16 by the pressure responsive diaphragm 48 and governor 21 respectively. This operation will be best understood by a specific example. Assume that the machine is operating, the various parts being in balanced positions with the pilot valves closed, and that a decrease in the quantity of fluid extraction occurs which tends to increase the stage pressure. Diaphragm 48 is raised thereby lowering pilot valve 42 to effect an opening of the stage valves and a decrease in the stage pressure and also lowering pilot valve 64 to effect a closing movement of valve 12^a as already explained, actuating fluid being admitted to the upper side of piston 14 through pipe 67 and discharged from the other side through pipe 66. As piston 14 moves downward it lowers pilot valve 16 so as to admit actuating fluid to the underside of piston 14 and permits it to discharge from the upper side, pilot valve 16 thus operating exactly opposite to pilot valve 64. The pressures on opposite sides of piston 14 thus become balanced and the piston remains stationary pending the movements of the pilot valves back to normal positions by the speed governor and diaphram.

The use of internal balanced valves for controlling the flow of elastic fluid from the extraction stage to the next lower stage is of advantage in that it enables elastic fluid of any desired pressure to be extracted without effecting the operation of the valves. This is of particular utility when elastic fluid of high pressure is to be extracted for under such conditions if the valves are not balanced it becomes very difficult to operate them. The use of an external ring for operating the valves brings such mechanism outside the turbine shell where it is not subjected to difficulties arising from expansion and heating of the parts.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A multistage elastic fluid turbine having a conduit for extracting elastic fluid from a stage of intermediate pressure, fluid-actuating motor - operated valves for controlling the flow of elastic fluid from the extraction stage to the next lower stage, means responsive to said intermediate pressure for controlling said fluid actuated motor, and a fluid actuated motor controlled by the governor for operating the main admission valve of the turbine, in which the pressure responsive means controlling the first-mentioned fluid actuated motor also controls an auxiliary supply of fluid for operating the fluid actuated motor of the main admission valve.

2. A multistage turbine, as claimed in Claim 1, in which the stems of the valves controlling the passage of fluid from the extraction stage to the next lower stage project radially from the turbine casing and are operated by means of a ring surrounding the casing.

3. A multistage turbine as claimed in Claim 2, in which the ring is provided with cams and is rotated around the casing by a fluid-actuated motor controlled by the pressure responsive means.

4. A multistage turbine as claimed in Claims 1, 2 or 3, in which a diaphragm between the extraction stage and the next lower stage is provided with a plurality of groups of nozzles, separate balanced valves controlling the flow of elastic fluid to each group of nozzles, and means for successively opening and closing the valves.

5. A multistage turbine as claimed in Claim 4, provided with cams located outside the turbine casing for successively opening and closing the valves, and means responsive to the extraction stage pressure for moving the cams.

6. In a multistage elastic fluid turbine as claimed in Claim 5, temperature responsive means for adjusting the pressure responsive cam operating means.

7. In a multistage elastic fluid turbine, the combination of a valve for admitting high pressure elastic fluid, a conduit for extracting elastic fluid from an intermediate stage, a valve controlling the flow of elastic fluid from the extraction stage to the next lower stage, a fluid actuated motor for each of said valves, a speed governor for actuating the motor for the first named valve, and means responsive to the extraction stage pressure for actuating both said motors.

8. A multistage elastic fluid turbine, having a conduit for extracting elastic fluid from a stage of intermediate pres-

sure, a nozzle diaphragm between the extraction stage and the next lower stage, a plurality of balanced valves having stems projecting through the turbine casing controlling the flow of elastic fluid through the diaphragm, a ring surrounding the turbine casing and carrying means for opening the valves, a fluid actuated motor for moving the ring, a movable abutment subjected to the extraction stage pressure for controlling the motor, a spring which opposes the movement of the abutment, and temperature responsive means for varying the setting of the spring.

9. A multistage turbine of the extraction type constructed arranged and operating substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 14th day of May, 1924.

JOHN GRAY,
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Agent for the Applicants.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1925.

[This Drawing is a reproduction of the Original on a reduced scale]

Fig.1.

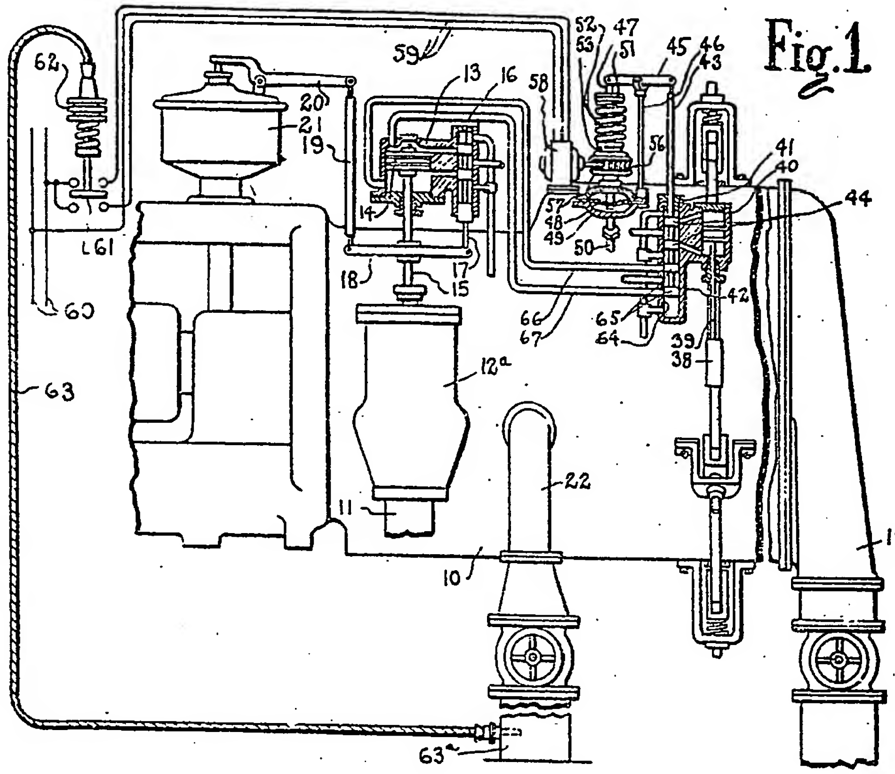
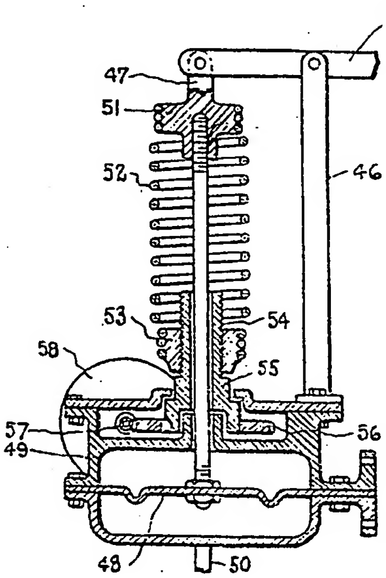


Fig.2.



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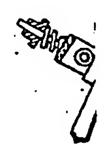

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Fig. 3.

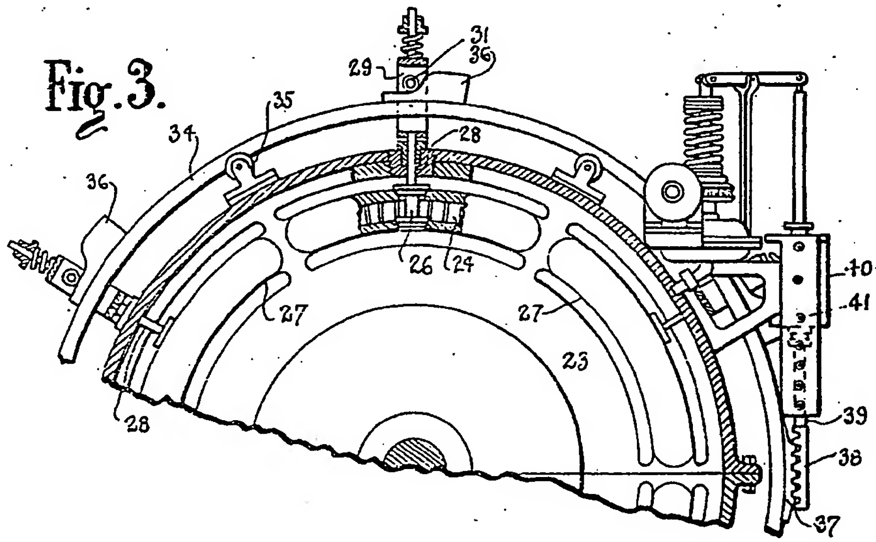

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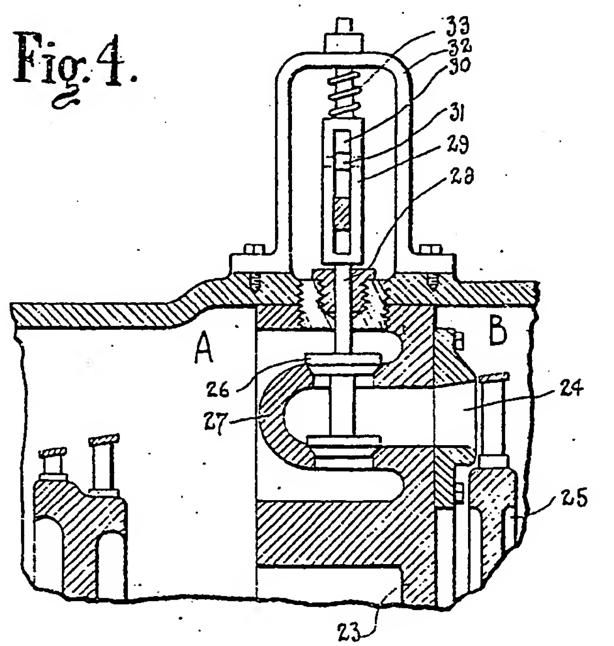
Fig. 4.



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2 SHEETS

SHEET 1

Fig.1.

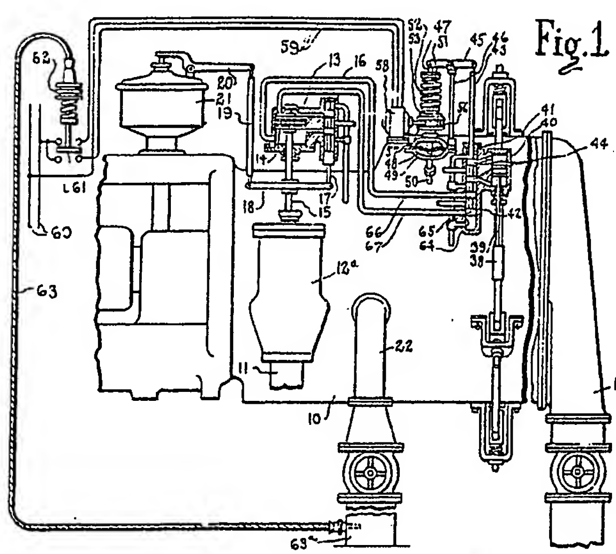
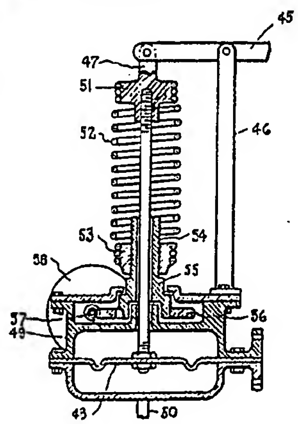


Fig.2.



SHEET 2

Fig.3.

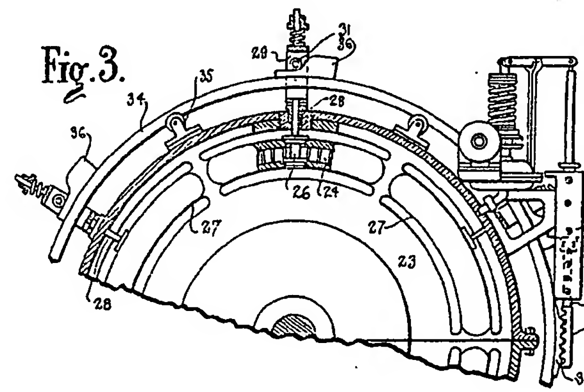
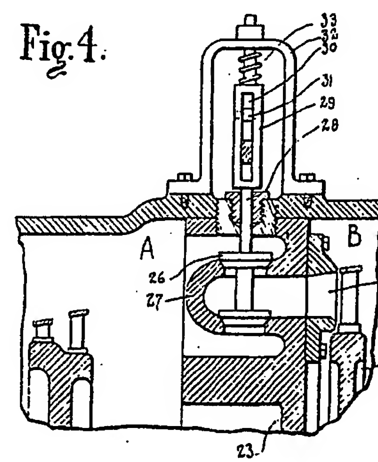


Fig.4.



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